Claims 4, 5, 14, 19, 31, and 33 have now been rewritten in independent form including all of the limitations of the independent claims from which they depend and any intervening claims, and therefore are now in condition for allowance.

35 U.S.C. § 112 Rejection

Claim 14 has been rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 14 has been amended to correct antecedent basis for "the bias voltage port"as recited on line 5. Claim 14 now recites "a" bias voltage port.

35 U.S.C. § 102 Rejection

Claims 1-3, 6-9, 12, 13, 15-18, 21-23, 26, 29, 30, and 32 have been rejected under 35 U.S.C. § 102 (b) as being anticipated by Arevalo (U.S. Patent 6,104,986).

The present invention relates to a phase shifter that achieves a wider phase shift range using a pair of varactor diodes, where the varactor tuning range is limited. The varactor tuning range is defined as the ratio of maximum capacitance to the minium capacitance achievable in the varactor by varying the applied bias voltage. The varactor tunning range is typically 5 to 1, which achieves a phase variation of approximately 90 degrees. The present invention provides an even greater phase shift range (greater than 90 degrees) by using a different characteristic impedance between quadrature ports than is used at its input/output ports. This is accomplished by embedding a first impedance transformer between the input port and a first quadrature port and embedding a second impedance transformer between the output port and a second quadrature port. As shown in Fig. 4B, the introduction of the impedance transformers provide a dramatic increase in the amount of available phase shift range.

Arevalo provides for a controller for controlling a voltage controlled phase shifting circuit for shifting the phase of a high frequency input signal. The phase shifter is constructed in a typical 3 dB hybrid structure using microstrip elements in each of its four legs. The phase shifter also includes first and second reverse-biased diodes electrically connected to the microstrip elements and operate as

varactors. Arevalo accomplishes its phase shift using the controller to drive a digital-to-analog (D/A) converter to control the bias voltage of the phase shifting circuit and thereby adjust the phase shift of a high frequency output signal relative to the high frequency input signal.

In order for a claim to be invalid under 35 U.S.C. § 102(b), the reference must teach every element of the claim. The Examiner actually concedes that Arevalo does not teach or otherwise suggest "a characteristic quadrature port impedance, being different from the input/output port impedance." We agree. Independent claims 1and 16 include this claim language and are thus patently distinguishable from Arevalo. Applicants respectfully request withdrawal of the rejection of claims 1 and 16 under 35 U.S.C. § 102(b). Dependent claims 2, 3, 6-13, 15, and 34 depend from claim 1 and dependent claims 17, 18, 20-30, and 32 depend from claim 16 and are allowable for the same reasons.

<u>35 U.S.C. § 103 Rejection</u>

Although the Examiner cites 35 U.S.C. § 102(b) as being grounds for the rejection, the Applicant also believes the Examiner may have intended to cite 35 U.S.C. § 103(a) as additional grounds for the rejection.

The Examiner was of the opinion that it would be obvious to use a different characteristic impedance between quadrature ports than is used at its input/output ports. However, most engineers are conditioned to use 50 ohms as the standard characteristic impedance of microwave devices. This is similar to engineers using a 75 ohm characteristic impedance as the standard impedance of television cables. Because of this conditioning, engineers are not likely to vary the transmission line impedance in microwave devices, and most certainty would not use a different characteristic impedance between quadrature ports than is used at its input/output ports as is claimed in the present invention.

As mentioned above, Arevalo uses a typical 3 dB hybrid structure when constructing its phase shifter. As such, Arevalo's engineers are also conditioned to use 50 ohms as the standard characteristic impedance and also would not think of varying the transmission line impedance to achieve a wider phase shift range. Thus, Arevalo does not teach or otherwise suggest using a different characteristic impedance between quadrature ports than is used at its input/output ports to achieve a

wider phase shift range. Therefore, it is respectfully submitted that the Examiner has failed to establish a prima facie case of obviousness under 35 U.S.C. § 103(a).

It is submitted in view of the above remarks, claims 1 and 16 are novel and non-obvious as they incorporate advantageous techniques contrary to previously accepted wisdom and blueprints for the inventive apparatus and method cannot be found in Arevalo. Accordingly, it is submitted that independent claims 1and 16 are in condition for allowance over Arevalo.

Further examination and reconsideration of the rejection of claims 1 and 16 and corresponding dependent claims 2, 3, 6-13, 15, 17, 18, 20-30, 32, and 34 is respectfully requested.

CONCLUSION

In view of the above amendments and remarks, it is believed that all claims (1-34) are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned at (978) 341-0036.

Respectfully submitted,

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MARKED UP VERSION OF AMENDMENTS

Claim Amendments Under 37 C.F.R. § 1.121(c)(1)(ii)

4. (Twice Amended) [An apparatus as in Claim 1 wherein the coupling between the input port and the output port is provided by coupled lines.] A phase shifter circuit for imparting a phase shift to an input signal applied at an input port such that a phase shifted signal appears at an output port, the circuit comprising:

an input port coupled to receive the input signal;

an output port coupled to provide the phase shifted output signal, the output port coupled to the input port by coupled lines, such coupling between the input port and output port having a characteristic input/output impedance;

a first quadrature port and a second quadrature port, the first and second quadrature ports coupled to one another, such coupling between quadrature ports having a characteristic quadrature port impedance, being different from the input/output port impedance;

a first impedance transformer coupled between the input port and a first one of the quadrature ports, the first impedance transformer transforming the characteristic input/output impedance across the input/output ports to the characteristic quadrature port impedance across the quadrature ports; and

a second impedance transformer coupled between a second one of the quadrature ports and the output port, the second impedance transformer transforming the characteristic quadrature port impedance across the quadrature ports to the characteristic input/output impedance.

5. (Amended) [An apparatus as in Claim 1 wherein the coupling between the quadrature ports is provided by coupled lines.] A phase shifter circuit for imparting a phase shift to an input signal applied at an input port such that a phase shifted signal appears at an output port, the circuit comprising:

an input port coupled to receive the input signal;

an output port coupled to provide the phase shifted output signal, the output port coupled to the input port, such coupling between the input port and output port having a characteristic input/output impedance;

a first quadrature port and a second quadrature port, the first and second quadrature ports coupled to one another by coupled lines, such coupling between quadrature ports having a characteristic quadrature port impedance, being different from the input/output port impedance;

a first impedance transformer coupled between the input port and a first one of the quadrature ports, the first impedance transformer transforming the characteristic input/output impedance across the input/output ports to the characteristic quadrature port impedance across the quadrature ports; and

a second impedance transformer coupled between a second one of the quadrature ports and the output port, the second impedance transformer transforming the characteristic quadrature port impedance across the quadrature ports to the characteristic input/output impedance.

14. (Amended) An apparatus as in Claim 1 wherein a Radio Frequency (RF) choke is applied between [the] a bias voltage port and one of the quadrature ports.

19. (Amended) [A method as in Claim 16 wherein the coupling between the input port and the output port is provided by coupled lines.] A method for imparting a phase shift to an input signal applied at an input port such that a phase shifted signal appears at an output port, the method comprising the steps of:

receiving the input signal at an input port;

providing the phase shifted output signal at an output port, the output port coupled to the input port by coupled lines, such coupling between the input port and output port having a characteristic input/output impedance;

coupling a first quadrature port to a second quadrature port, such coupling between quadrature ports having a characteristic quadrature port impedance, being different from the input/output port impedance;

coupling a first impedance transformer between the input port and a first one of the quadrature ports, the first impedance transformer transforming the characteristic input/output impedance across the input/output ports to the characteristic quadrature port impedance across the quadrature ports; and

coupling a second impedance transformer between a second one of the quadrature ports and the output port, the second impedance transformer transforming the characteristic quadrature port impedance across the quadrature ports to the characteristic input/output impedance.

31. (Amended) [A method as in Claim 16 wherein a Radio Frequency (RF) choke is applied between the bias voltage port and one of the quadrature ports.] A method for imparting a phase shift to an input signal applied at an input port such that a phase shifted signal appears at an output port, the method comprising the steps of:

receiving the input signal at an input port;

providing the phase shifted output signal at an output port, the output port coupled to the input port, such coupling between the input port and output port having a characteristic input/output impedance;

coupling a first quadrature port to a second quadrature port, such coupling between quadrature ports having a characteristic quadrature port impedance, being different from the input/output port impedance;

coupling a first impedance transformer between the input port and a first one of the quadrature ports, the first impedance transformer transforming the characteristic input/output

impedance across the input/output ports to the characteristic quadrature port impedance across the quadrature ports;

coupling a second impedance transformer between a second one of the quadrature ports and the output port, the second impedance transformer transforming the characteristic quadrature port impedance across the quadrature ports to the characteristic input/output impedance; and

applying a Radio Frequency (RF) choke between a bias voltage port and one of the quadrature ports.

33. (Amended) [An apparatus as in Claim 8 wherein an input bias voltage is applied to at least one of the varactor diodes.] A phase shifter circuit for imparting a phase shift to an input signal applied at an input port such that a phase shifted signal appears at an output port, the circuit comprising:

an input port coupled to receive the input signal;

an output port coupled to provide the phase shifted output signal, the output port coupled to the input port, such coupling between the input port and output port having a characteristic input/output impedance;

a first quadrature port and a second quadrature port, the first and second quadrature ports coupled to one another, such coupling between quadrature ports having a characteristic quadrature port impedance, being different from the input/output port impedance;

a first impedance transformer coupled between the input port and a first one of the quadrature ports, the first impedance transformer transforming the characteristic input/output impedance across the input/output ports to the characteristic quadrature port impedance across the quadrature ports;

a second impedance transformer coupled between a second one of the quadrature ports and the output port, the second impedance transformer transforming the characteristic quadrature port impedance across the quadrature ports to the characteristic input/output impedance; and

at least one varactor diode is coupled to at least one quadrature port, wherein an input bias voltage is applied to at least one of the varactor diodes.